REMARKS

Entry of this Amendment is proper because it narrows the issues on appeal and does not require further search by the Examiner.

Claims 1-2, 5, 7-9, 11 and 13-43 are all the claims presently pending in the application. Claims 1-2, 5, 11, 17, 19, 22, 25, 30, 36, 38-40 and 43 have been amended to more clearly define the invention. Claims 1, 39 and 43 are independent.

It is noted that the claim amendments are made only for more particularly pointing out the invention, and <u>not</u> for distinguishing the invention over the prior art, narrowing the claims or for any statutory requirements of patentability. Further, Applicant specifically states that no amendment to any claim herein should be construed as a disclaimer of any interest in or right to an equivalent of any element or feature of the amended claim.

Claims 1-2, 5, 9, 11, 15, 17, 19, 21-22, 24-25, 27-30, 32-33 and 35-43 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Goetz, et al., (U.S. Patent No. 6,441,393) and Major, et al., (U.S. Patent No. 6,100,546).

This rejection is respectfully traversed in the following discussion.

I. THE CLAIMED INVENTION

The claimed invention is directed to a light-emitting semiconductor device including a substrate, plural semiconductor layers which are made of group III nitride group compound semiconductor formed on the substrate, and an active layer having a multiple quantum well structure.

Importantly, the multiple quantum well structure includes <u>a quantum well layer which satisfies the formula $Al_{1-x}In_xN$, a composition ratio x of indium (In) being in a range of $0.1 \leq x \leq 1$, and a quantum barrier layer which satisfies the formula $Al_{1-z-y}Ga_yIn_zN$ ($0 \leq y \leq 1$, $0 \leq z < 1$, $0 \leq z+y \leq 1$), alternately formed with the quantum well layer. a composition ratio y of gallium (Ga) in the quantum barrier layer being one of $y=1$, $y \approx 1$, and $0.9 < y \leq 1$.</u>

Conventional light-emitting semiconductor devices may include a multiple quantum well (MQW) structure having well layers formed of GaInN and barrier layers formed of GaN. However, such conventional devices experience problems. Specifically, in such devices, the performance life is short and the driving voltage (e.g., oscillation threshold) is high.

The claimed device, on the other hand, includes an active layer having a multiple quantum well structure which includes a quantum well layer which satisfies the formula $Al_{1-x}In_xN$, a composition ratio x of indium (In) being in a range of $0.1 \leq x \leq 1$, and a quantum barrier layer which satisfies the formula $Al_{1-z-y}Ga_yIn_zN$ ($0 \leq y \leq 1$, $0 \leq z < 1$, $0 \leq z+y \leq 1$), alternately formed with the quantum well layer, a composition ratio y of gallium (Ga) in the quantum barrier layer being one of $y=1$, $y \approx 1$, and $0.9 \leq y \leq 1$. With such a configuration, the claimed invention is able to provide a light-emitting semiconductor device which emits rays having a desired and useful wavelength (Application at page 12, lines 8-11), and is able to reduce the amount of indium needed to form the quantum barrier layer (Application at page 13, lines 8-13).

II. THE GOETZ AND MAJOR REFERENCES

The Examiner alleges that Goetz would have been combined with Major to form the claimed invention. Applicant submits, however, that these references would not have been combined, and even if combined, the combination would not teach or suggest each and every element of the claimed invention.

Goetz discloses a semiconductor device having n-type device layers of III-V nitride, with donor dopants such as germanium (Ge), silicon (Si), tin (Sn), and/or oxygen (O), and/or p-type device layers of III-V nitride, having acceptor dopants such as magnesium (Mg), beryllium (Be), Zinc (Zn), and/or cadmium (Cd), either simultaneously or in a doping superlattice (Goetz at Abstract).

Major discloses a III-V arsenide-nitride semiconductor device in which group III elements are combined with group V elements, in concentrations chosen to lattice match commercially available crystalline substrates (Major at Abstract).

However, Applicant submits that these references would not have been combined as alleged by the Examiner. Indeed, these references are directed to completely different problems and objectives.

Specifically, as noted above, the Goetz device is intended to engineer strain, improve conductivity, and provide longer wavelength light emission by selective doping, whereas Major is merely directed to a arsenide-nitride semiconductor device in which the concentrations are varied method to allegedly produce an overall lattice match and desired

bandgap (Major at Abstract). Thus, these references are directed to completely different subject matter and no person of ordinary skill in the art would have considered combining the references as alleged by the Examiner, absent impermissible hindsight.

Further, Applicant submits that the Examiner can point to no motivation or suggestion in the references to urge the combination as alleged by the Examiner. Indeed, the Examiner merely states that Major discloses "specific advantages associated with all of the materials in the entire phase diagram for AlGaInN", and "[l]attice matching to known substrates, and to other layers" which provide motivation for "choosing any specific range of In concentration". (Office Action at page 2, line 21-page 3, line 7). However, Applicant respectfully submits that one of ordinary skill in the art would not have been so motivated to combine the reference as alleged by the Examiner. Thus, the Examiner has clearly failed to make a prima facie case of obviousness.

Moreover, neither Goetz, nor Major, nor any combination thereof teaches or suggests *"a quantum well layer which satisfies the formula $Al_{1-x}In_xN$, where a composition ratio x of indium (In) is in a range of $0.1 \leq x \leq 1$; and a quantum barrier layer which satisfies the formula $Al_{1-z-y}Ga_yIn_zN$ ($0 \leq y \leq 1$, $0 \leq z < 1$, $0 \leq z+y \leq 1$), alternately formed with said quantum well layer, wherein a composition ratio y of gallium (Ga) in said quantum barrier layer is one of $y=1$, $y \approx 1$, and $0.9 < y \leq 1$"*, as recited in claim 1 similarly recited in claims 39 and 43.

As noted above, unlike conventional light-emitting semiconductor devices which may include a quantum well layer formed of GaInN and quantum barrier layer formed of GaN, the claimed device, includes an active layer having a multiple quantum well structure which includes a quantum well layer which satisfies the formula $Al_{1-x}In_xN$, a composition ratio x of indium (In) being in a range of $0.1 \leq x \leq 1$, and a quantum barrier layer which satisfies the formula $Al_{1-z-y}Ga_yIn_zN$ ($0 \leq y \leq 1$, $0 \leq z \leq 1$, $0 \leq z+y \leq 1$), alternately formed with the quantum well layer, a composition ratio y of gallium (Ga) in the quantum barrier layer being one of $y=1$, $y \approx 1$, and $0.9 < y \leq 1$. With such a configuration, the claimed invention is able to provide a light-emitting semiconductor device which emits rays having a desired and useful wavelength (Application at page 12, lines 8-11), and is able to reduce the amount of indium needed to form the quantum barrier layer (Application at page 13, lines 8-13).

Clearly, these features are not taught or suggested by the cited references. Indeed, these references do not even disclose or suggest at least one of the problems (e.g., a high driving voltage) which the claimed invention was intended to address.

As noted above, Goetz merely discloses using AlInN as a material in an MQW layer. But Goetz fails to teach or suggest using $Al_{1-x}In_xN$ ($0.1 \leq x \leq 1$) in a quantum well layer <u>of an active layer having an MQW structure</u>.

The Examiner alleges that the disclosure of an active layer including AlInN in Goetz teaches the active layer including $Al_{1-x}In_xN$ ($0.1 \leq x \leq 1$) in the claimed invention. However, Applicant respectfully submits that this is incorrect.

Specifically, the Examiner alleges that "AlInN means the amount of In can vary from 0 to 1, and this range encompasses 0.1 to 0, and therefore anticipates that range of 0.1 to 1" (Office Action at page 2, lines 12-13). However, the Examiner's logic is incorrect. Indeed, using this erroneous logic, for example, it could be said that "AlInN means the amount of N can vary from 0 to 1".

In other words, using the Examiner's erroneous logic, any element in the compound could have a composition ratio ranging from 0 to 1. Thus, the Examiner alleges that the term "AlInN" could be construed to include a binary compound such as AlN (where In=0) or InN (where Al=0) which is clearly incorrect. Moreover, the "amount of N" could be "0" which would result in a material AlInN being devoid of N. Of course, this does not make sense and illustrates the fallacies of the Examiner's logic.

Indeed, the Examiner's selection of the lower and upper limits (e.g., 0 and 1) is completely arbitrary. The Examiner does not explain why this range and why not, for example, the range 0.5 to 0.8.

The fact of the matter is that the term "AlInN" means nothing more than the ternary compound AlInN. It does not suggest any particular proportion (e.g., composition ratio) for the elements Al, Ga, In or N, as suggested by the Examiner (e.g., see Major at Figure 2 and col. 7, line 64-col. 8, line 2).

Therefore, the term "AlInN" in Goetz does not teach or suggest any particular range as suggested by the Examiner's incorrect logic. Therefore, <u>Goetz's teaching of AlInN clearly does not teach or suggest any range of In and certainly does not teach or suggest an active layer having a quantum well layer including $Al_{1-x}In_xN$ ($0.1 \leq x \leq 1$), as in the claimed invention</u>.

Further, the Examiner attempts to make up the deficiencies of Goetz by relying on Major. However, Major fails to make up for the many deficiencies in Goetz.

Specifically, the Examiner states that "[w]ith respect to the dependent claims, the composition ranges are encompassed by the Major teaching of AlGaInN, particularly in view

of the diagram of Major figure 2" (Office Action at page 3, lines 8-9). Thus, presumably the Examiner is alleging that Figure 2 in Major teaches an active layer which includes "*a quantum barrier layer which satisfies the formula* $Al_{1-z-y}Ga_yIn_zN$ *(*$0\leq y\leq 1$*,* $0\leq z<1$*,* $0\leq z+y\leq 1$*), alternately formed with said quantum well layer, wherein a composition ratio y of gallium (Ga) in said quantum barrier layer is one of* $y=1$*,* $y\approx 1$*, and* $0.9<y\leq 1$" as recited, for example, in claim 1. However, Figure 2 of Major clearly does not provide such a teaching.

In fact, Major is directed to an arsenide-nitride device. Thus, Major is completely different from the device of the claimed invention which has a active layer which does not necessarily include arsenic.

Further, Figure 2 in Major is described as a graph plotting the bandgap and lattice constant of AlGaInN wurtzite crystals superimposed with the lattice constant of some common substrates (Major at col. 6, lines 17-19). Figure 2 may be used, for example, to select a substrate on which to form certain compounds, based on a lattice matching.

However, Figure 2 in Major does not teach or suggest <u>an active layer having a multiple quantum well structure which includes a quantum well layer which satisfies the formula $Al_{1-x}In_xN$, a composition ratio x of indium (In) being in a range of $0.1\leq x\leq 1$, and a quantum barrier layer which satisfies the formula $Al_{1-z-y}Ga_yIn_zN$ ($0\leq y\leq 1$, $0\leq z<1$, $0\leq z+y\leq 1$), alternately formed with the quantum well layer, a composition ratio y of gallium (Ga) in the quantum barrier layer being one of $y=1$, $y\approx 1$, and $0.9<y\leq 1$</u>. Indeed, Figure 2 says nothing about a multiple quantum well structure of an active layer and is completely unrelated to such a structure.

Indeed, nowhere does Major teach or suggest the novel features of the claimed invention. For example, referring to Figure 10, Major discusses an active layer 255 of a light-emitting device. Specifically, Major states that "the active layer can be formed by sequential growth of an monolayer of GaN, followed by growth of two monolayers of AlN, followed by one monolayer of GaN, which is followed by two more monolayers of AlN, etc." (Major at col. 15, lines 23-28).

In other words, nowhere in this passage or anywhere else for that matter, does Major teach or suggest the claimed composition ratios for the quantum well layer and the quantum barrier layer of the claimed invention. Therefore, contrary to the Examiner's allegations, Major does not make up for the deficiencies of Goetz.

Therefore, Applicant submits that these references would not have been combined, and even if combined, the combination would not teach or suggest each and every element of the claimed invention. Therefore, the Examiner is respectfully requested to withdraw this rejection.

III. FORMAL MATTERS AND CONCLUSION

In view of the foregoing, Applicant submits that claims 1-2, 5, 9, 11, 15, 17, 19, 21-22, 24-25, 27-30, 32-33 and 35-43, all the claims presently pending in the application, are patentably distinct over the prior art of record and are in condition for allowance. The Examiner is respectfully requested to pass the above application to issue at the earliest possible time.

Should the Examiner find the application to be other than in condition for allowance, the Examiner is requested to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary in a telephonic or personal interview.

The Commissioner is hereby authorized to charge any deficiency in fees or to credit any overpayment in fees to Attorney's Deposit Account No. 50-0481.

Respectfully Submitted,

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CERTIFICATION OF FACSIMILE TRANSMISSION

I hereby certify that I am filing this Amendment After Final by facsimile with the United States Patent and Trademark Office to Examiner Sara W. Crane, Group Art Unit 2811 at fax number (703) 872-9319 this 2nd day of October, 2003.

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